The difficult airway in trauma: What you need to know

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ABSTRACT: Airway evaluation and management are generally the first priority for treatment of trauma patients from the prehospital setting throughout their hospital stay. Delay in recognition of an airway problem, or inability to oxygenate or ventilate because of an inadequate airway, will lead to rapid death. Therefore, all clinicians involved in the care of trauma patients should have adequate knowledge of current best practices for airway evaluation and management. In addition, trauma providers should develop and maintain the skills needed to perform various airway maneuvers to establish and maintain an adequate airway. While elective airway management has the luxury of time for thorough airway evaluation, the airway management in the trauma setting does not allow this same opportunity. For this reason, all trauma airways should be presumed to be a difficult airway, and teams should prepare accordingly. This review will summarize the best practices for airway evaluation and management for trauma patients from the prehospital setting through the emergency department. (*J Trauma Acute Care Surg.* 2024;97: 661–669. Copyright © 2024 Wolters Kluwer Health, Inc. All rights reserved.)

KEY WORDS: Airway; cricothyroidotomy; emergency department; intubation; prehospital.

PREHOSPITAL AIRWAY MANAGEMENT

For a variety of reasons, trauma airway management in the prehospital setting presents a significant challenge. Factors such as the outdoor environment, poor lighting, patient positioning (including maintaining cervical spine stabilization), limited resources, and varying levels of expertise, make prehospital trauma airway management much different than management at the trauma center. In this context, prehospital airway evaluation and management should be simplified with a focus on an open airway rather than a definitive airway. In addition, a low Glasgow Coma Scale (GCS), which is an indication for endotracheal intubation (ETI) in the emergency department (ED), should not be an indication for a definitive airway in the prehospital setting.

Initial Evaluation

While there are multiple anatomic and physiologic factors that are assessed to predict the difficult airway,[1] the emergent nature of prehospital trauma airway management does not allow the luxury of time for a detailed airway assessment. For this reason, it should be assumed that every trauma patient will have a difficult airway, and first responders should be prepared to manage difficult airways in all scenarios.

The initial evaluation of the prehospital evaluation involves one question: is the airway open? If the patient has a patent airway and is oxygenating and ventilating spontaneously, then they can be transferred to the nearest trauma center without need for any airway intervention. If there is a problem with any of the above, then prehospital airway management may begin with basic airway maneuvers. It should be noted that the airway should be continuously reassessed even after performing airway maneuvers, as the clinical condition can change at any time.

Basic Airway Maneuvers

Many airway problems in trauma patients can be temporarily managed with basic maneuvers, facilitating efficient transport, and definitive airway management can be deferred to the trauma center. These basic maneuvers may include a jaw thrust, oropharyngeal airway (OPA) and nasopharyngeal airway (NPA). Because the cervical spine should remain in a neutral position, the head tilt-chin lift maneuver cannot be used in trauma patients. Adjuncts to the jaw thrust include the OPA and NPA. An OPA is placed in the mouth to move the tongue anteriorly and keep the upper airway open. It should not be placed in patients with an intact gag reflex, as it may induce vomiting. An NPA is placed through one or both nares to open the nasopharyngeal passage. It should not be placed in patients with midface fractures, to avoid placing it through the base of the skull and into the brain.

If these basic maneuvers open the airway and the patient is breathing spontaneously, then only supplemental oxygen for hypoxia may be needed. If these maneuvers maintain a patent airway but the patient is not oxygenating and/or ventilating, the next steps are noninvasive management, which includes high-flow oxygen and bag-valve mask (BVM) ventilation. Bag-valve mask is used in conjunction with jaw thrust, OPA, and/or NPA to keep the airway open. Advantage of BVM is its rapid initiation without need for inserting a device into the airway itself. In addition, there are abundant data showing that there is no difference in survival, neurological function, or return of spontaneous circulation between BVM and more advanced airway techniques.[2] There are several situations where BVM may be ineffective or unsuccessful. These include patients with

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large beards or other facial features that prevent forming an adequate seal on the face, as well as patients with extensive facial fractures. In addition, BVM is best performed with two providers, one to maintain the seal and the other to ventilate, so in situations where only a single provider is available to ventilate, especially when transport time is relatively long, escalating to a more advanced airway may be indicated.

These noninvasive maneuvers should allow airway management in the vast majority of trauma patients in the prehospital setting. However, if these maneuvers do not work and either the airway is compromised, or the patient cannot oxygenate and ventilate, then more invasive airway management will be necessary. These invasive airway maneuvers include blind insertion airway devices (BIADs), ETI, and surgical airway.

Blind Insertion Airway Device

The BIAD is a relatively new type of device that is placed quickly and blindly and does not require the experience, time, or equipment of ETI. These devices are designed to be placed and create a seal above the opening of the trachea, allowing ventilation without needing to see the device pass through the vocal cords. The most commonly used BIADs in the prehospital setting include the i-Gel, the King Laryngeal Tracheal, and the laryngeal mask airway (LMA). There are many different brands and types of BIAD currently on the market, but the majority are functionally similar to these three. The LMA and i-Gel have similar morphology, with a wide base designed to fit over the glottis to form a seal. They differ in that the LMA has an inflatable cuff, while the i-Gel's distal cuff is formed from a soft flexible polymer and has a port for an orogastric tube. The King Laryngeal Tracheal is designed for its distal end to be inserted into the esophagus blindly, with a distal esophageal cuff to obstruct gastric secretions and a proximal cuff designed to sit just above the larynx, allowing ventilation between balloons. All these devices are available in multiple sizes.

There is no significant difference in insertion time among these different devices,[3] and the major complication associated with these devices is aspiration of gastric contents.[4] Multiple variations available have gastric channels intended to reduce the risk of aspiration, but the possibility should not be discounted. Few studies have directly compared prehospital BIAD with ETI. One such study published in 2015 compared prehospital BIAD with ETI in trauma patients with GCS of ≤8.[5] There was no difference in mortality and no advantage or benefit to ETI. This would indicate that BIAD should be the first prehospital option in patients who cannot have their airway managed with noninvasive techniques.

Prehospital ETI

The most definitive method of airway management is ETI. Paramedics have performed ETI in the prehospital setting for many decades and continue to be trained to do so. However, as mentioned before, the focus of prehospital airway management in trauma should be an open airway and not a definitive airway. Despite this, there may be some trauma patients who require a definitive airway with ETI in the prehospital setting. This primarily applies to patients who have failed noninvasive maneuvers to maintain an open airway or cannot oxygenate and ventilate because of an airway issue. In addition, there are some situations where the prehospital team may determine that ETI is warranted as an initial maneuver, like a prolonged transport time or a limitation of personnel available for airway management. During prolonged transport, it may not be feasible to manage an unstable airway for an extended period of time. Similarly, airway management may require two providers, especially during BVM, so a more invasive airway may be indicated. In both of these situations, a BIAD should be the first airway of choice, and ETI should be reserved for patients where BIAD fails or is not available. Should ETI be attempted in the prehospital setting, proper preparation is required, including the necessary equipment, medications, and personnel, which will be discussed later in this review.

Over the last several decades, there have been multiple studies showing either no benefit or worse outcomes with ETI versus less invasive maneuvers. Two of the earlier studies out of San Diego investigated the role of ETI in patients with presumed traumatic brain injury (TBI). The first, published in 2003, was a prospective cohort study of trauma patients with a prehospital GCS of ≤8 and compared rapid sequence induction (RSI) with nonintubated historic controls.[6] Rapid sequence induction with ETI patients had longer scene times, more hyperventilation, and a higher mortality. In addition, RSI with ETI was independently associated with mortality. In a follow-up study in 2005, the same group published a San Diego county-wide multicenter study looking at ETI versus noninvasive airway management of 13,625 patients and found that ETI patients had a higher mortality and ETI was independently associated with mortality.[7] Three more recent studies similarly found either no benefit[8,9] or worse outcomes[10] with prehospital ETI in patients with severe TBI.

The evolution of this literature presumably should have led to a decrease in prehospital ETI utilization in trauma patients. A recent review found significant changes in prehospital procedures performed from 2014 to 2021.[11] In particular, the authors found that the use of a prehospital advanced airway decreased from 21% to 12%. Despite this decrease, a prehospital advanced airway continued to be independently associated with an increase in mortality. Over the last several decades, it has become clear that the prehospital airway of the trauma patients should be managed with the least invasive means possible. Prehospital providers should take a tiered approach to airway management, starting with noninvasive maneuvers, followed by BIAD, and finally reserving ETI for specific situations where all other techniques fail. The Western Trauma Association recently published an algorithm (Fig. 1) summarizing a practical approach to the prehospital management of the airway for trauma patients.[12]

Prehospital Surgical Airway

In select cases, providers may find that they are neither able to ventilate nor intubate. In these cases, it may be reasonable to perform a surgical airway after all other rescue options have been exhausted. Techniques for surgical airway in the prehospital setting include needle-guided methods and standard surgical cricothyrotomy (described later in this review). These procedures are performed rarely, and therefore, there are relatively little data on their success rates or complications in this setting, but there is some evidence that prehospital providers have more success with a standard open approach compared with needle-guided access.[13]

Prehospital Providers

Airway management by emergency medical services (EMS) providers depends not only on the patient condition and

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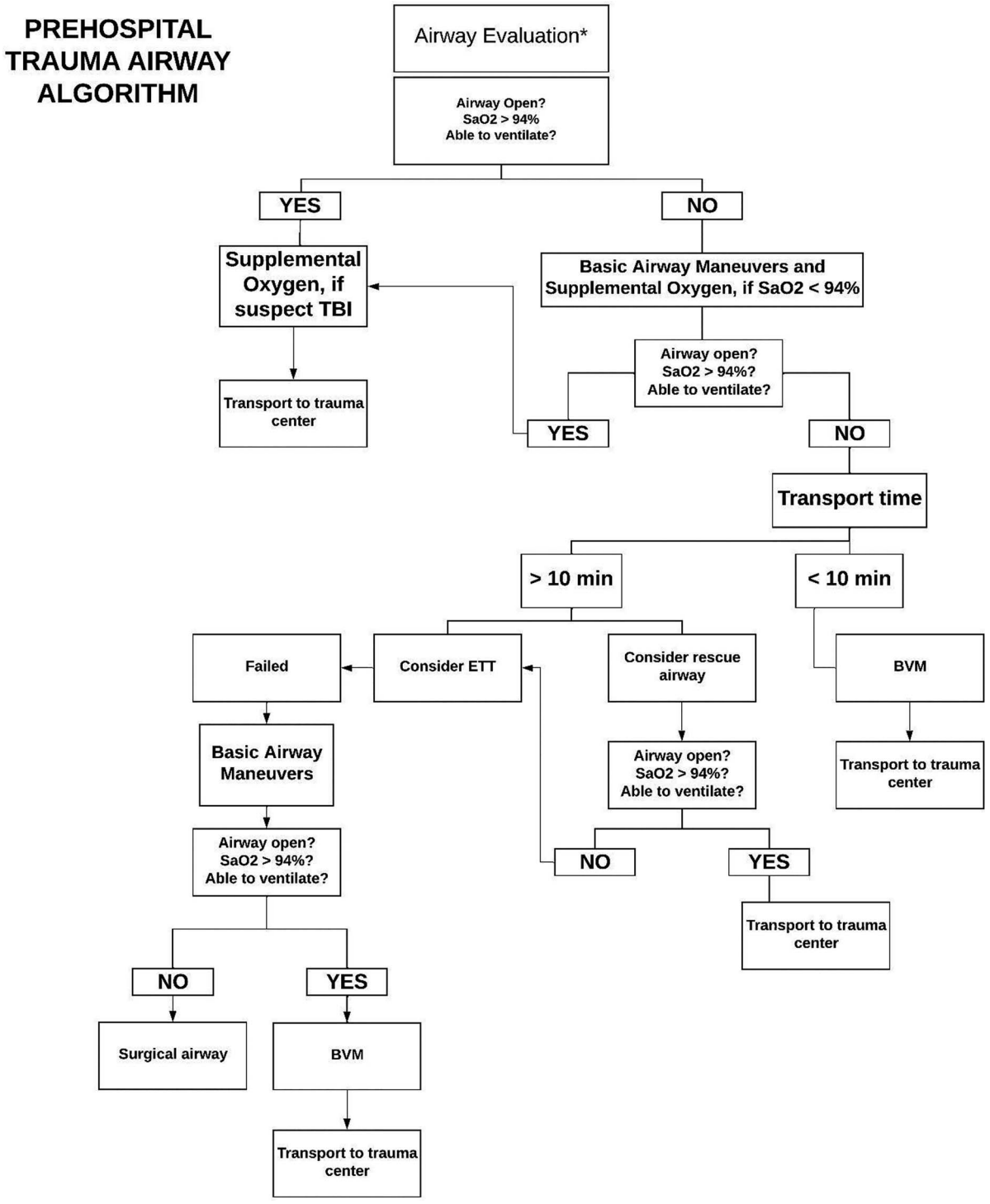

Figure 1. Prehospital trauma airway algorithm.

accessible equipment but also on provider level. Certification and credentialing of EMS personnel essentially occur at three different levels. These include emergency medical technicians (EMTs), advanced EMTs, and paramedics. Emergency medical technician providers have the least amount of required training and education and are subsequently limited to basic airway maneuvers including BVM ventilation and placement of OPA or NPA airway adjuncts. Advanced EMTs and paramedics have more intensive training and allowed more invasive airway procedures. Paramedic education includes advanced airway skills including ETI and surgical airway.

Emergency medical services providers can receive certification through state and national organizations but become credentialed to practice by their organization's medical director.

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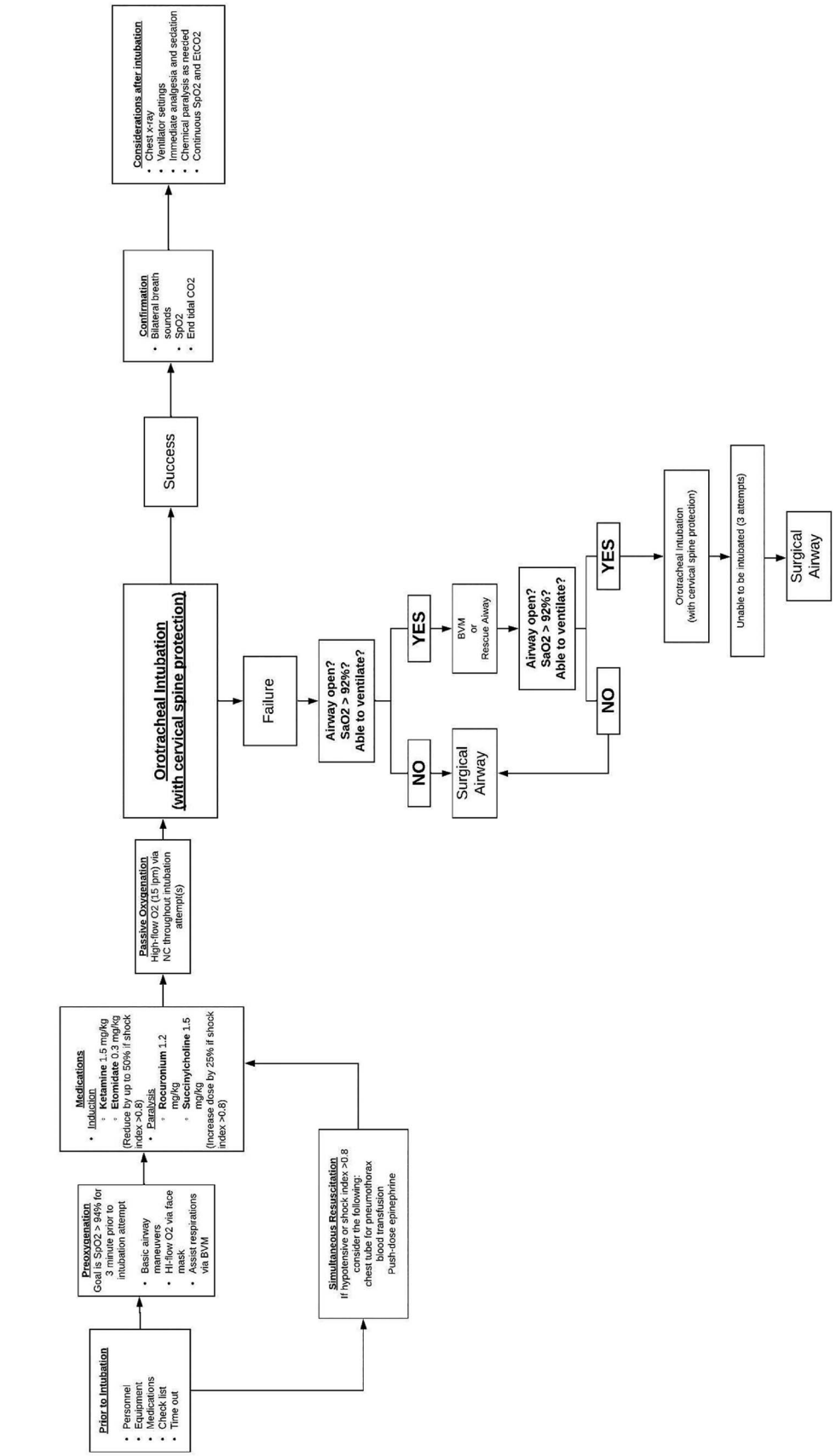

Figure 2. Emergency department trauma airway algorithm.

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Credentialing provides EMS personnel with authorization on which procedures can be performed at their level of training. Credentialing criteria are somewhat variable in the United States; some levels are determined by state or regional EMS oversight organizations, and other states allow the medical director to dictate allowable procedures.

The role of pharmacologically assisted intubation in EMS, including RSI and delayed-sequence induction, continues to be somewhat controversial. Generally, EMS providers have been able to successfully demonstrate a high rate of successful intubation in the field; however, overall, these patients tend to have worse outcomes as discussed previously. There are likely multiple reasons contributing to this, including less optimal intubating conditions, less experienced providers, increased risk of contaminated airways, less ability to appropriately resuscitate the patient prior to intubation, and challenges related to appropriately managing the intubated patient. Emergency medical services medical directors are ultimately faced with the decision on whether this intervention should be permitted, accounting for multiple factors including provider level of training and experience, access to appropriate equipment and medications, and other variables such as transport times. If allowed, it is imperative that EMS medical directors maintain a comprehensive initial education and ongoing competency training along with a robust quality assessment and improvement process.

ED AIRWAY MANAGEMENT

Once the trauma patient arrives in the ED, airway management continues to be a top priority. Although the general principles of airway management remain the same, the situation changes significantly. In the ED, there is an optimal environment and a large team of airway experts at the ready with essentially unlimited options for equipment and medications. In addition, while the prehospital priority is an open airway, in the ED, the trauma team will be required to establish a definitive airway in severely injured patients who present with airway compromise. The Western Trauma Association has also published a recommended guideline for trauma airway management in the ED (Fig. 2).[12]

Preparation Prior to Patient Arrival

One advantage of trauma airway management in the ED is the luxury of time to prepare prior to patient arrival. Patients with reported prehospital airway compromise, or those at risk for airway compromise (e.g., GSS ≤8), should trigger the highest level of trauma activation. This activation will assemble all the personnel needed for trauma airway management, including nurses, respiratory therapists, emergency medicine physicians, anesthesiologist, and trauma surgeons. In addition, all airway equipment and necessary medications should be prepackaged and readily available prior to arrival. An intubation checklist may be considered in this setting to make sure all personnel, equipment, and medications are ready prior to patient arrival, as an intubation checklist is associated with a decreased risk of hypoxic events during intubation.[14]

Initial Evaluation

Airway evaluation is the first step after trauma patient arrival to the hospital. Similar to the prehospital setting, airway evaluation in the ED must be expedited and all airways should be presumed to be a difficult airway. Airway assessment tools, such as the Mallampati classification and Look-Evaluate-Mallampati-Obstruction-Neck mobility score, are often used to evaluate the airway in the elective setting but may not be feasible in the trauma setting because of the emergent and uncontrolled nature of the trauma airway.[15] However, a brief history and physical examination may provide useful information indicating a more difficult than expected airway.

Simply asking a patient their name, as well as their ability to respond, can provide an indication that the airway is grossly intact and further management may be deferred, at least temporarily. If a patient cannot answer because of mental status, or hoarseness, stridor, or gurgling is appreciated, then a more challenging airway should be expected. Physical examination findings indicating a potentially more difficult airway include direct trauma to the face or neck, evidence of a burn or inhalation injury (singed nasal or facial hairs, oral edema, or erythema), obesity, or the presence of a beard. In addition, most blunt trauma patients will require a cervical collar and spine immobilization until the spine can be cleared, making airway management more difficult.

Indications

Indications for a definitive airway in the ED will depend on injury patterns and patient physiology. Direct airway injury, although uncommon, is probably the most urgent indication for a definitive airway. Significant burns to the face may cause airway edema and should prompt intubation in the trauma bay. Acute hypoxic respiratory failure after trauma may be due to rib fractures, flail chest, or a pulmonary contusion. However, in a hypoxic patient, a pneumothorax should be identified and treated prior to a definitive airway, as intubation may convert a simple pneumothorax to a tension pneumothorax.

Hemodynamic instability is not an indication for a definitive airway, and in fact, intubating a hemodynamically unstable should be avoided if possible, as it may worsen hemodynamics or lead to cardiac arrest. Neurologic impairment is the most common indication for a definitive airway. Patients with a GCS of ≤8 should be intubated during the primary survey because they are unable to protect their airway. A definitive airway should be considered in severely agitated patients, especially if they are a threat to themselves or to the health care team, or the trauma evaluation cannot be completed because of the agitation. Patients with a high spinal cord injury should also be intubated during the primary survey. Although they may initially appear to be breathing comfortably, these patients will likely progress to respiratory failure and require emergent intubation later in their hospital course.

Preoxygenation

Once it has been decided that a definitive airway is required, the first step is preoxygenation. This can be delivered via facemask for 3 to 5 minutes at 100% FiO_2 in the spontaneously breathing patient or with the assistance of BVM (with or without NPA/OPA) in the apneic or hypoventilating patient. Although not traditionally part of emergent ETI, preoxygenation has more recently been recognized as an essential maneuver to limit hypoxia during airway management. Preoxygenation replaces nitrogen with oxygen in the large and small airways,[16] thus delaying hypoxia that may occur during intubation. Desaturation occurs slowly from 100% to 90% SpO_2 but drops precipitously

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once below 90%.[17] Preoxygenation will keep the patient above 90% SpO2 for a longer period of time, giving the team more time to establish an airway without desaturation.

Following preoxygenation, hypoxia can further be prevented during the intubation process with passive oxygenation. While the patient is apneic during the procedure, nasal cannula can be used to deliver oxygen to the alveoli and maintain a high enough partial pressure of oxygen to allow diffusion into the bloodstream. While patients may still become acidotic because of accumulation of carbon dioxide, maintenance of oxygen levels remains important in these patients, and passive oxygenation has been shown to reduce the rate of hypoxia in the postintubation period.[18]

Medications

Trauma patients should be intubated in the ED using RSI, and the primary classes of medications given during RSI are an induction agent and a paralytic. Induction agents are sedating medications that have rapid onset of action and occasionally have analgesic and amnestic properties. Agents in common use include etomidate, ketamine, and propofol. Etomidate is a short-acting hypnotic agent that is commonly used in trauma intubations because of its rapid onset and clearance, decrease in cerebral metabolic rate, and relatively minimal effect on hemodynamics.[19] One significant concern with the use of etomidate is its association with adrenal insufficiency in critically ill patients; however, this has primarily been studied in septic patients, not in trauma, and data have not shown an increase in mortality in those patients.[20]

Ketamine is an induction agent that is unique in that it provides analgesia and sedation. While it has activity as a negative inotrope, it also can increase heart rate and blood pressure by inhibiting catecholamine reuptake. There has been some concern over the use of ketamine in patients with TBI because of potential risk of increased ICP, but there have been a large amount of data suggesting that this is not the case, and it is safe to use in this population.[21,22] Given its theoretical benefit in patients who are hypotensive prior to induction, ketamine has gained traction as a drug of choice for induction in trauma patients.[23] Propofol is commonly used by anesthesiologists as an induction agent in the operating room and has been used in RSI, but it can cause profound hypotension and decrease in cerebral blood flow and therefore should be used with utmost caution in the unstable trauma population. A recent multicenter study published in 2020 investigated the use of different induction agents during RSI for trauma patients.[24] The authors tracked changes in heart rate and blood pressure for patients after receiving etomidate, ketamine, or propofol for induction and found no difference in hemodynamics regardless of agent used.

The most commonly used paralytic agents for RSI are succinylcholine and rocuronium. Succinylcholine is a depolarizing agent that acts at acetylcholine receptors and often produces noticeable muscle fasciculation prior to paralysis. It has a rapid onset of 30 to 45 seconds and lasts 5 to 10 minutes and therefore has an ideal pharmacokinetic profile for RSI. However, it can cause a transient increase in serum potassium levels and should be avoided in patients who have severe cellular damage causing release of intracellular potassium, as in preexisting quadriplegia or paraplegia, severe burns, and crush injuries >12 to 24 hours old. Rocuronium is a nondepolarizing agent that is also commonly used that does not cause the same potassium increase. However, it does have a slightly longer onset at 60 to 90 seconds and duration of 30 to 60 minutes. There has been some concern about the duration of action should intubation fail, but this is lessened with the availability of rescue airway devices and reversal with sugammadex, so rocuronium has become the first line paralytic for RSI at some institutions.[25]

Simultaneous Resuscitation

Before, during, and after the management of a definitive airway, consideration should be given to simultaneous resuscitation of the severely injured patient, as the maneuvers before and during ETI may lead to significant physiologic derangement. Trauma patients who are being intubated should be managed using the "circulation first" or "CAB" approach, rather than the traditional ABC approach.[26,27] This circulation first approach will defer a definitive airway, if possible, and address deranged physiology prior to establishing the definitive airway. Prior to induction, paralysis, and ETI, the airway can be managed noninvasively as discussed in the prehospital section. Simultaneous resuscitation should include diagnosing and treating a hemo- or pneumothorax, transfusing whole blood or component therapy in a 1:1:1 fashion, and stopping any external bleeding with direct pressure, topical hemostatics, or a tourniquet. In addition, patients should receive "push-dose pressors" prior to the induction agent to stave off hypotension during intubation.[28,29] These pressors are particularly important in patients who have an airway problem that requires immediate action and there is limited time for resuscitation.

Endotracheal Intubation

Once the patient has been received induction and paralytic, and passive oxygenation is ongoing, the patient is ready for ETI. The preferred route for all trauma intubations is orotracheal intubation. There is no role for awake nasotracheal or fiberoptic intubation in trauma patients, as nasotracheal intubation requires a spontaneously breathing patient, and fiberoptic intubation requires a tremendous amount of time and preparation to perform. In addition, nasotracheal intubation in trauma patients is associated with increased mortality.[30]

Orotracheal intubation can be performed using either direct laryngoscopy (DL) or video laryngoscopy (VL). Direct laryngoscopy intubation, using either a Miller or Macintosh blade, has historically been the only ETI method. However, the relatively recent development of VL has changed the landscape of ETI in trauma patients. While both methods are acceptable and have a high success rate during emergent intubations, VL intubations are becoming more common all the time. A recent prospective, randomized, multicenter trial with 1,417 patients directly compared DL and VL for emergent intubations of critically ill adults in either the ED or ICU.[31] The study investigated rates of successful intubation on first attempt and found that VL was than DL for all patients (85% vs. 71%). In addition, VL was better in all subgroups including obese patients, trauma patients, difficult airways, intubations in the ED or ICU, and when the intubating physician had limited previous intubating experience. The only two groups where VL was no better than DL was in physicians with extensive overall intubating

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experience and those with limited prior VL experience. While VL appears to be superior to DL for emergent intubations, physicians must maintain DL proficiency for situations where VL is not available, does not work, or view is obscured because of blood in the airway.

In blunt trauma patients, cervical spine immobilization should be maintained during the intubation process. Rather than intubating with the cervical collar in place, the preferred method for cervical spine immobilization in emergency intubation is removal of the cervical collar and maintaining manual in-line stabilization. While there are some data to suggest that manual in-line stabilization results in mildly decreased intubation success compared with no stabilization,[32] Manual in-line stabilization outperforms stabilization with cervical hard collar.[33] In penetrating trauma, cervical spine immobilization is not indicated, and the airway can be managed as in the uninjured patient.[34]

Airway Confirmation

Once a definitive airway has been established, its placement must be verified. One reliable method of airway confirmation is visualization of the endotracheal tube passing through the vocal cords into the trachea. While this was historically only seen by the intubating physician, the advent of VL has allowed the entire trauma team to visualize this essential step. The second objective and reliable method of airway confirmation is end-tidal CO_2 detection, as it confirms successful intubation with nearly 100% sensitivity.[35] Qualitative measurement of CO_2 is conducted through a colorimetric device that changes colors based on the partial pressure of CO_2. This is in comparison with quantitative measures exhibited as the waveform of the concentration of CO_2 over time, with a normal range between 30 and 40 mm Hg. Some factors that may lead to an inaccurate measurement of CO_2 include hypotension or cardiac arrest, obstructive pulmonary pathology distal to the tube, and splashing of gastric on contents onto the probe altering the pH of the colorimetric device. Maneuvers that are not reliable indicators of airway confirmation include chest rise and fall, presence of breath sounds, and misting of the endotracheal tube. Although a chest x-ray does not confirm placement of the tube in the trachea, it should be performed to confirm correct endotracheal tube depth within the trachea, 2 to 3 cm above the carina.

Failed Intubation

A failed intubation is one of the most stressful clinical scenarios the trauma team will encounter. However, the trauma surgeon must remain calm and lead the team through this difficult situation. The first step after a failed intubation is to fall back on basic, noninvasive airway management. This may include a jaw thrust, OPA, NPA, supplemental oxygen, and BVM. If the patient can be oxygenated and ventilated with noninvasive maneuvers, the team has the time to regroup and prepare for the next intubation attempt. Before the second attempt, the team should consider changing approach to intubation including escalating to a more experienced physician to intubate or changing intubation technique (e.g., DL to VL or change of blade). Furthermore, intubating adjuncts like a gum elastic bougie may be considered. Given its slim character and curved coude tip compared with an ETT tube, it can be easier to direct it into an anterior position under the epiglottis and into the trachea. Once in position, the laryngoscope can be removed, and the endotracheal tube can be advanced over the bougie. There are some data to support that difficult airway intubations are more successful on first attempt with bougie when compared with an endotracheal tube.[36] Finally, a BIAD may be placed in the ED to allow time for further planning for a definitive airway. In general, after three failed intubation attempts, the patient should receive a surgical airway. However, if the patient cannot be oxygenated and ventilated with noninvasive techniques, a surgical airway should be performed after the first failed attempt.

Surgical Airway

A surgical airway is a lifesaving procedure that needs to be performed rapidly and safely. The first step is the decision to perform a surgical airway, and this decision should be definitive, as any delay in the procedure may lead to death. The surgeon should have close oversight of the airway management and have an internal trigger for when to perform a surgical airway; this may include a number of failed attempts or a threshold of oxygen saturation that will prompt a surgical airway, keeping in mind that oxygen desaturation occurs rapidly once below 90%. Equipment needed for a surgical airway includes a scalpel, a hemostat, and an airway, which may be a 6-0 endotracheal tube or size 6 tracheostomy. There is no need for a large instrument set because this will only complicate an already tense situation. In addition, there is no role for a skin prep or drape during a surgical airway.

Once the decision has been made to perform a surgical airway, the larynx should be grasped with the nondominant hand, and the cricothyroid membrane should be identified and palpated with the index finger of the nondominant hand. The nondominant hand should not move again until the airway is in place. This is essentially a blind procedure, and there will be little to no visualization, so it is essential to palpate and maintain anatomic awareness of the cricothyroid membrane. The membrane may be more difficult to palpate in women or obese patients or in the presence of an anterior neck hematoma. Once the cricothyroid membrane is identified, either a vertical or transverse skin incision is made, but we prefer a vertical incision to ideally avoid anterior jugular veins and to allow proximal or distal extension if initial incision is not centered over the cricothyroid membrane. The initial incision should divide the skin, subcutaneous tissue, platysma, and strap muscles, with one or two swipes of the scalpel. Next, a transverse incision is made into the cricothyroid membrane, large enough to allow passage of the airway. The incision into the airway may be dilated with the index finger or a hemostat, and then, the airway is placed through the opening. Intratracheal position of the airway is confirmed in the same was as an ETI described previously, and the tube is sutured in place. There is no need to convert a surgical airway to a tracheostomy, and the cricothyrotomy may be used as the airway until decannulated.[37]

After Intubation

Once the airway is secured and confirmed within the trachea with capnography or end-tidal CO_2, it should be secured with tape or sutured in place if a surgical airway, to prevent its dislodgment. A right mainstem intubation is relatively common

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after emergent intubation, especially in children and small adults,[38] so a chest x-ray should be performed to assure appropriate depth in the trachea. Continued analgesia and sedation should be administered with consideration of patient hemodynamics and need for neurological assessment. We prefer fentanyl and propofol infusions. Postintubation hypotension should be evaluated to rule out life-threatening causes related to airway management, such as tension pneumothorax, which can develop in the setting of positive airway pressures with an underlying pneumothorax.

AUTHORSHIP

V.E., J.H., J.K., J.B., and C.V.R.B. contributed in the conception and study design. V.E., J.H., J.K., J.B., and C.V.R.B. contributed in the literature review. V.E., J.H., J.K., J.B., and C.V.R.B. contributed in the data acquisition. V.E., J.H., J.K., J.B., and C.V.R.B. contributed in the data analysis and interpretation. V.E., J.H., J.K., J.B., and C.V.R.B. contributed in the drafting of the manuscript. C.V.R.B. contributed in the critical revision.

DISCLOSURE

Conflicts of Interest: Author Disclosure forms have been supplied and are provided as Supplemental Digital Content (http://links.lww.com/TA/D850).

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